



Advances in Civil Integrated Management (CIM)
NCHRP Domestic Scan 13-02
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What is Civil Integrated Management (CIM)

- ◆ The rapid development of information technologies and the growing need for accelerated project delivery with improved quality require all transportation stakeholders to *develop and utilize more effective ways of planning, designing, constructing, maintaining, operating and managing transportation facilities through their life cycle*. Civil Integrated Management (CIM) is generally being accepted as the preferred framework to achieve this goal in the highway industry. It is sometimes also referred to as Virtual Design and Construction, or VDC.
- ◆ It is known in the vertical construction industry as Building Information Modeling, or BIM.



What is Civil Integrated Management (CIM)



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- ◆ The core building blocks of CIM are 3D Engineered Models, which are compatible with technologies such as LiDAR (light detecting and ranging for surveying and establishing data points for physical features), subsurface geophysics (location of water table or buried objectives), automated machine guidance (AMG), Intelligent compaction (IC), and others. The departure from traditional document based project delivery and management to a system based on models necessitates redefined workflow processes; raises digital data storage and data interoperability issues; and also it awakens legal issues such as the ownership of digital data and models.

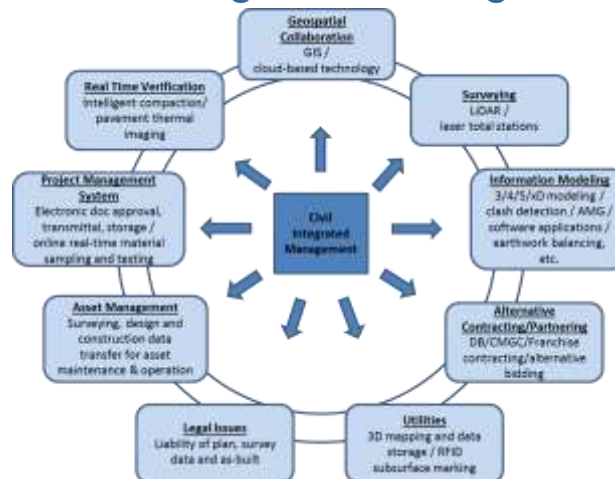


What is Civil Integrated Management (CIM)

- ◆ Based on the Federal Highway Administration (FHWA) definition of this new paradigm, the CIM Scan Team modified its definition of the term Civil Integrated Management (CIM) to read as follows:
- ◆ *“CIM is the technology-enabled collection, organization, managed accessibility, and the use of accurate data and information throughout the life cycle of a transportation asset. The concept may be used by all affected parties for a wide range of purposes, including planning, environmental assessment, surveying, design, construction, maintenance, asset management, and risk assessment.”*



What is Civil Integrated Management (CIM)



Why Civil Integrated Management (CIM)

777 Family

Computing & Design/Build Processes Help Develop the 777

CAD/CAM Systems



In the mid-1980s, The Boeing Company invested in three-dimensional CAD/CAM (computer-aided design/computer-aided manufacturing) technology. The pilot programs clearly demonstrated the benefits of modeling airplane parts as three-dimensional solids in the CATIA (computer-aided three-dimensional interactive application) system. CATIA - along with several Boeing-created applications - allowed Boeing engineers to simulate the geometry of an airplane design on the computer without the costly and time-consuming investment of using physical mock-ups.

Value of Digital Pre-Assembly

Studies show that the most pervasive problems in manufacturing airplanes are:

- * part interference (incidents of assembly parts overlapping each other) and
- * difficulty in properly fitting parts together in aircraft final assembly.

By 1989, Boeing was confident that it could significantly reduce the costly rework caused by these problems by digitally pre-assembling the airplane on the computer. The technology offered:

- * improved accuracy in part design and assembly,
- * instantaneous communication capability,
- * improving the quality of airplane designs, and
- * reduction of the time required to introduce new airplanes into the marketplace.

The opportunity to apply the new CAD/CAM approach as well as other new engineering and manufacturing ideas came in 1989 with the launch of the Boeing 777 twinjet.



Innovative Solutions for tomorrow's transportation needs


Why Civil Integrated Management (CIM)

777 Family

Computing & Design/Build Processes Help Develop the 777


Through innovative applications of computing technology, the 777 program exceeded its goal of reducing change, error and rework by 50 percent. Parts and systems have fit together better than anticipated and at the highest level of quality.

The first 777 was just .023 of an inch — about the thickness of a playing card — within perfect alignment while most airplane parts line up to within a half inch to each other.



**"If I can visualize it,
I can understand it."**

Albert Einstein



Innovative Solutions for tomorrow's transportation needs

Why Civil Integrated Management (CIM)



Why Civil Integrated Management (CIM)

- ◆ Summarizing ...
- ◆ The world is changing, and we are not obligated to perform site construction the way we did it 15 years ago.
- ◆ We reserve the right to make better decisions than we have in the past, by integrating data and information with new technologies for innovative solutions.
- ◆ Our goal is to make the model the basis of not only how we collaborate during design and construction of a project or corridor (Connected Site), but also how we maintain and manage the same corridor, as well as plan for future growth and changes (Life Cycle Management)



Why Civil Integrated Management (CIM)



Real Time Verification

Integrated with Construction

- Intelligent Compaction
- Pavement Thermal Imaging
- RFID for materials quantity and certification transmittal
- In-cab weight scales
- Video surveillance for remote construction inspection and recording



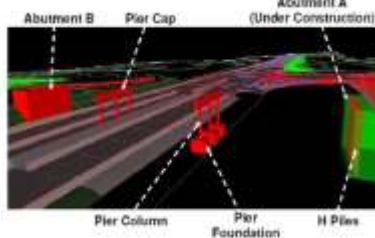
Surveying

Integrated with Construction

- Light Detection and Ranging (LiDAR)
- Equipment flexibility, precision and accuracy of survey, and data processing and storage
- Laser Total Stations



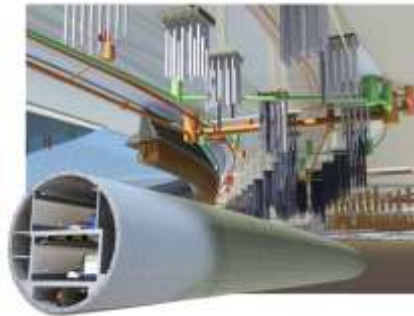
Why Civil Integrated Management (CIM)



Information Modeling

Integrated with Construction

- Public Outreach
- Software applications
- Optimizing construction means and methods
- Earthwork balancing
- Equipment automatic guidance control systems
- 3/4/5/x D Modeling



Utilities

Integrated with Construction

- 3D Mapping and data storage
- RFID subsurface marking



CIM Topics for Discussion

- ◆ Where are the potential savings & cost avoidances?
- ◆ How can construction schedules be streamlined & shortened?
- ◆ How will the quality of PS&E plans improve with model-based delivery?
- ◆ How can we collect & process data with appropriate accuracy & efficiency?
- ◆ How well will this work for both Design-Build and Design-Bid-Build projects?
- ◆ How will FDOT need to change its design reviews and construction reviews?
- ◆ What will be the investment in workforce training and data infrastructure?
- ◆ How will legal issues be handled when models are provided pre-bid?
- ◆ How will evolving technology issues be funded & supported?
- ◆ How will we keep up with future trends and applications?



NCHRP 20-68A “US Domestic Scan Program”

Scan 13-02 Advances In Civil Integrated Management (CIM)

Scan Team Visits Summer 2014



Scan 13-02 Advances in Civil Integrated Management (CIM)

- ◆ This scan was conducted as part of NCHRP Project 20-68A, the U.S. Domestic Scan program
- ◆ The program was requested by the American Association of State Highway and Transportation Officials (AASHTO), with funding provided through the National Cooperative Highway Research Program (NCHRP)
- ◆ Each scan is selected by AASHTO and the NCHRP 20-68A Project Panel and addresses a single technical topic of broad interest to many state departments of transportation and other agencies



Scan Team



Scan Team

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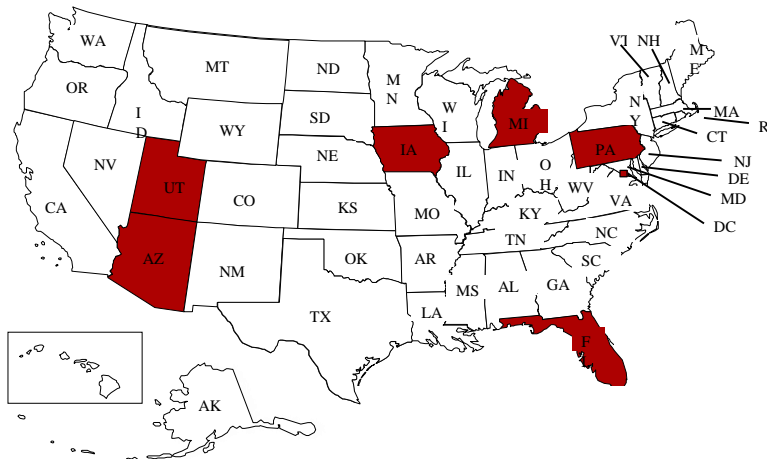
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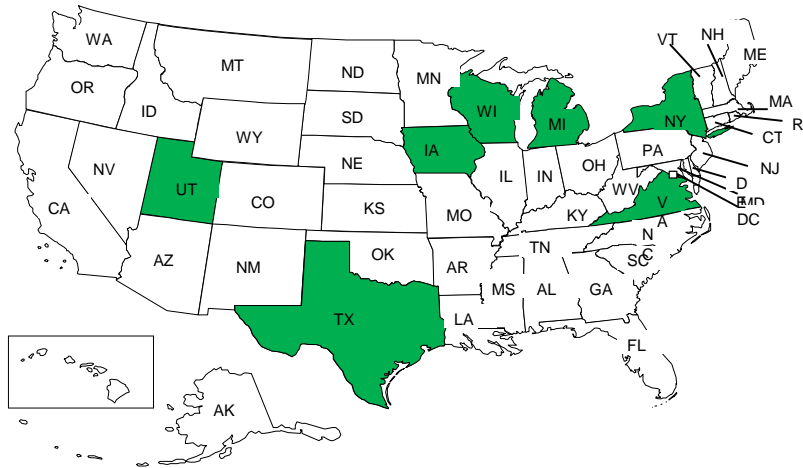
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Scan Team Members' Home States



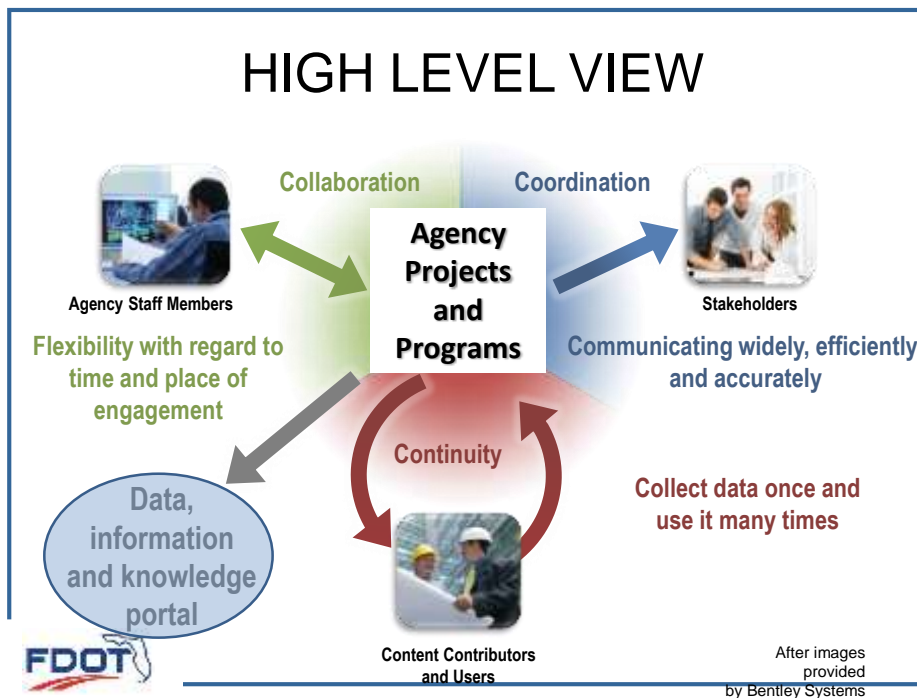
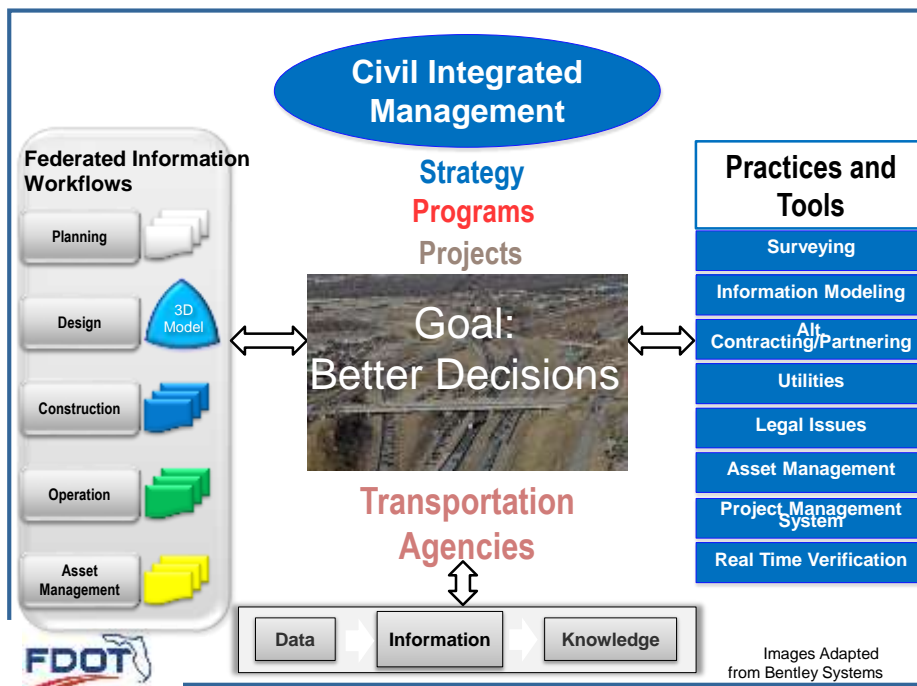
Scan Host States

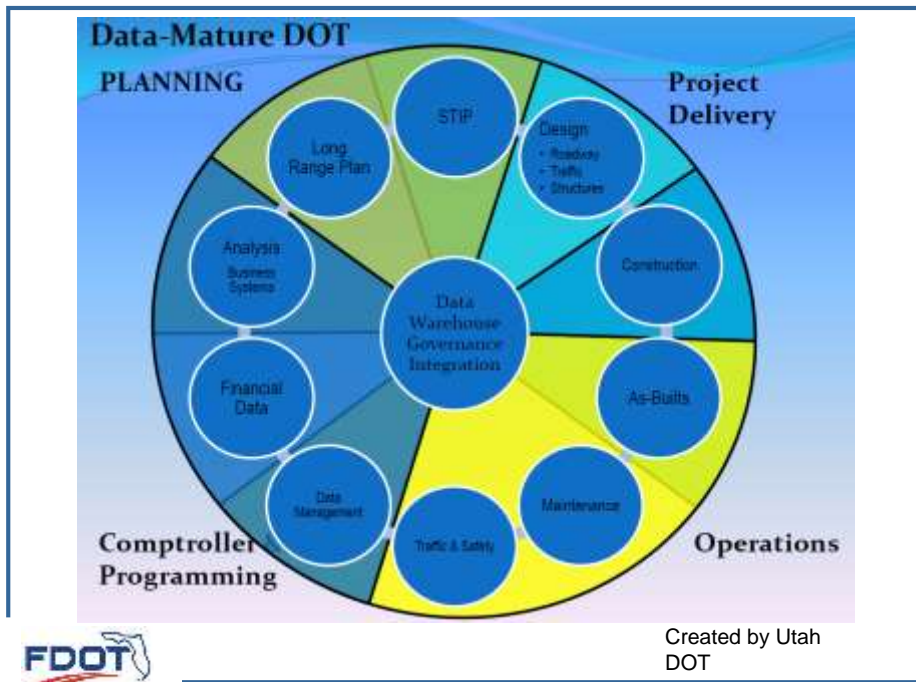
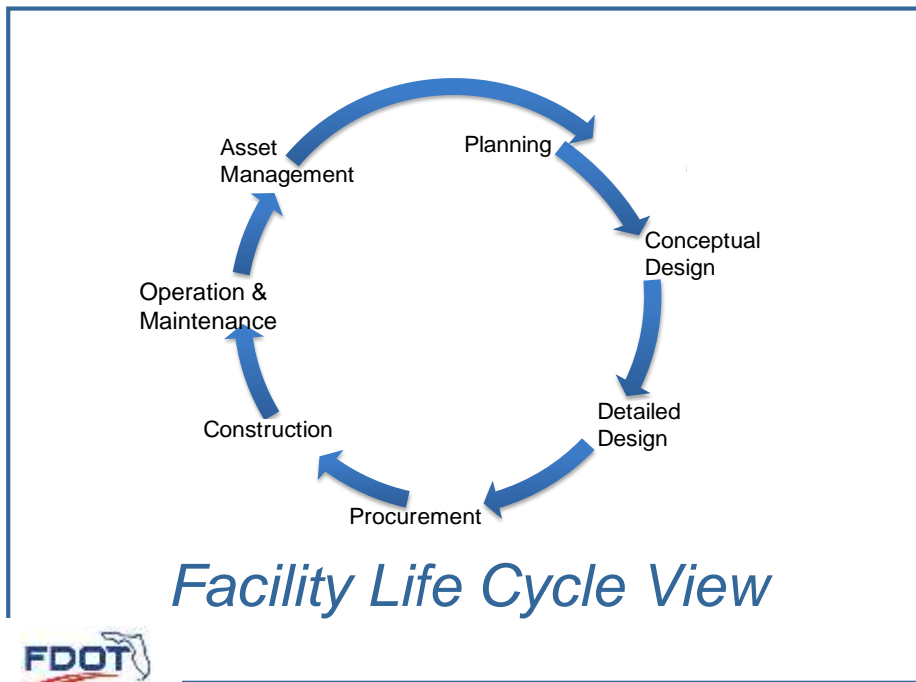


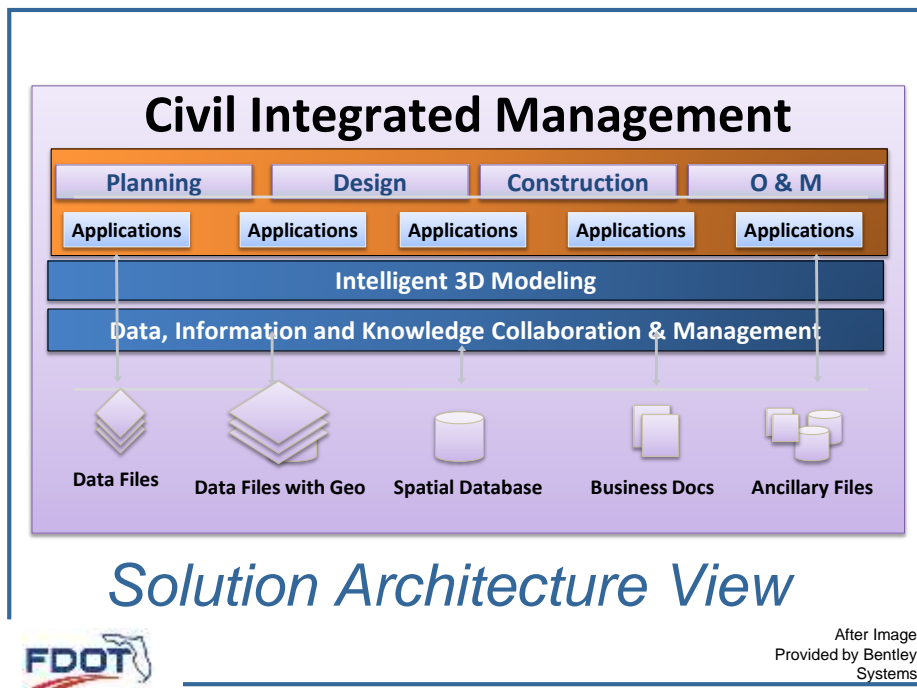
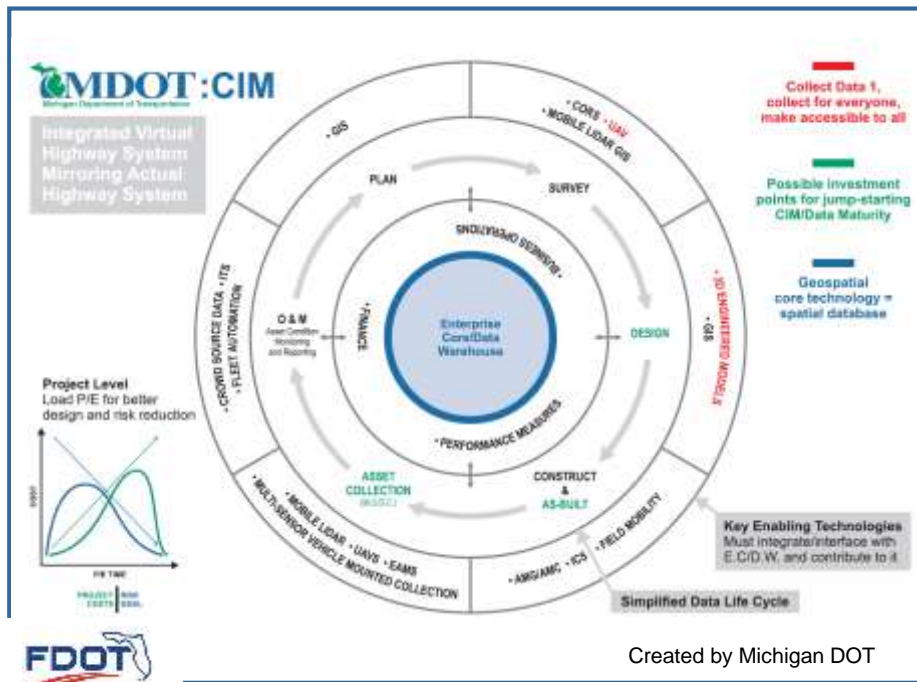
Main Focus Areas

- Technical factors (e.g. data interoperability, data governance, IT infrastructure)
- Organization factors (e.g. size of program, degree of centralization or decentralization, outsourcing) influencing the ability to utilize CIM
- Proven efficient intelligent construction technologies
- Construction project performance measures being used
- Successful partnering techniques, such as virtual meetings, wireless data sharing, and paperless communication
- The use of digital data to provide information and knowledge necessary for decisions during operations, asset management (including maintenance), and planning phases
- Opportunities to benefit an entire agency rather than just in the design and construction phases of a facility life cycle.
- Opportunities for the collection and use of geospatial data

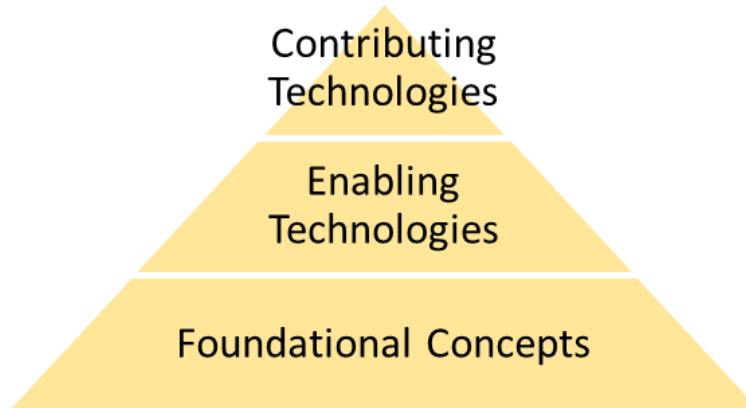








Key Findings - CIM Concepts



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- ◆ Foundational Concepts – Concepts for organizations to consider that can facilitate CIM implementation
- ◆ Enabling Technologies - Technologies that are highly useful in a CIM system
- ◆ Contributing Technologies - Technologies that may not be absolutely necessary for initial CIM implementation but have the potential to amplify the usefulness of a CIM system



Foundational Concepts

- Establishing a data warehouse or enterprise integration core that stores data, information and knowledge on existing transportation assets & new or planned transportation projects
- Promoting innovation within the whole agency, with vision but not in a vacuum
- Ensuring IT arrangements that are responsive to organizational business needs
- Enabling users to get needed data & improve decision making
- Employing model based design as a starting point for CIM implementation
- Considering other possible areas to jump start CIM, such as mass data acquisition and post construction as-builts



Foundational Concepts

- Thinking beyond next customer to ensure data remains useful during the entire facility lifecycle & throughout the enterprise
- Establishing a strong geospatial foundation and considering investments in the National Spatial Reference System (NSRS)
- Using common exchange formats to facilitate wide sharing of data
- Employing information modeling within the agency
- Making the required IT Investments (usually large) to support a large concept
- Collaborating with contractors, designers and utility trade groups to enhance the usefulness of CIM and enlist support



Enabling Technologies

- Geographic Information System (GIS)
- 3D Engineered Models
- Light Detection and Ranging (LiDAR)
- Global Positioning System (GPS)
- Automatic Machine Guidance (AMG)
- Mobile Devices / Mobile Computing
- Cloud Computing
- Electronic Document Management Systems



Contributing Technologies

- Intelligent Compaction (IC)
- Digital Data Collection
- Connected Site (i.e. Mobile Computing tracks location, activities, and facilitates data gathering and data display for equipment and personnel)
- Electronic Signatures
- Electronic Material Management
- 4D/5D (adding Schedule and Cost Dimensions to 3D Engineered Models)



Philosophies for Success

- It's a Galloping Horse – Find the best place you can to try and get aboard
- Find out where your data resides, who is collecting and storing it, in what format, and for what purpose
- Start with 3D model-centric design to gain momentum at the beginning of development
- Initial Success is important – consider the use of pilots
- CIM is a system of systems, do not define it too narrowly- consider all 3D models, GIS, databases, even pdf files
- Use data throughout the project life cycle. Collect it once, use it many times



Philosophies for Success

- Embrace the fundamental concept of a data warehouse with a data governance system – a single source of truth
- Interoperability over the life cycle of a facility requires considerable communication among entities
- Need management that encourages innovation and provides some space for risk and failure
- Passionate people are needed
- Cut the millennial generation loose to prove the value of CIM and score some early wins (likely more effective than measuring ROI)
- The devil is in the details including legal issues, data interoperability, personnel issues, IT security



Philosophies for Success

- Geospatial ... Geospatial ... Geospatial
- No more data silos or cylinders of excellence
- Scoping is more important than ever. Engage survey and construction staff in initial project development phases
- Initial Success is important – consider the use of pilots
- Program funding differently. Additional data gathering in project development can give big returns in later phases
- Recruit differently; manage differently
- Invest in technology on a continuing basis
- Data storage and accessibility is key



Why Civil Integrated Management (CIM)

- CIM will change the way that we do business; the Microwave Analogy
- Recognize that transportation agencies are rich in data that has enormous value
- We know how much technology has touched and changed our personal lives in many ways. We know that CIM and related technologies are here to stay
- Consider the power of what can be done with data that is collected under an effective data governance system and stored in a data warehouse in a format that can be accessed by many; the Grisham novel analogy



What About You

- Today's Takeaways ...
- CIM is a True Game Changer
- Where Can You Start? How Can You Get Aboard the Galloping Horse?
- Remember ... the Core Building Blocks of CIM are 3D Engineered Models
- Can You Accept the Challenge to Think Outside of the Box and Beyond Your Own Data Silo?

